Anatomy of a Safe and Effective Checklist

Checklists are meant to be highly customized documents that create an inherently safe operation by operating within a rigid, repeatable, and controlled framework. To maximize their effectiveness checklists can, and should, be tailored to specific operations and equipment. Ultimately, they should be treated as living documents that are updated as necessary and routinely analyzed for completeness and usefulness.

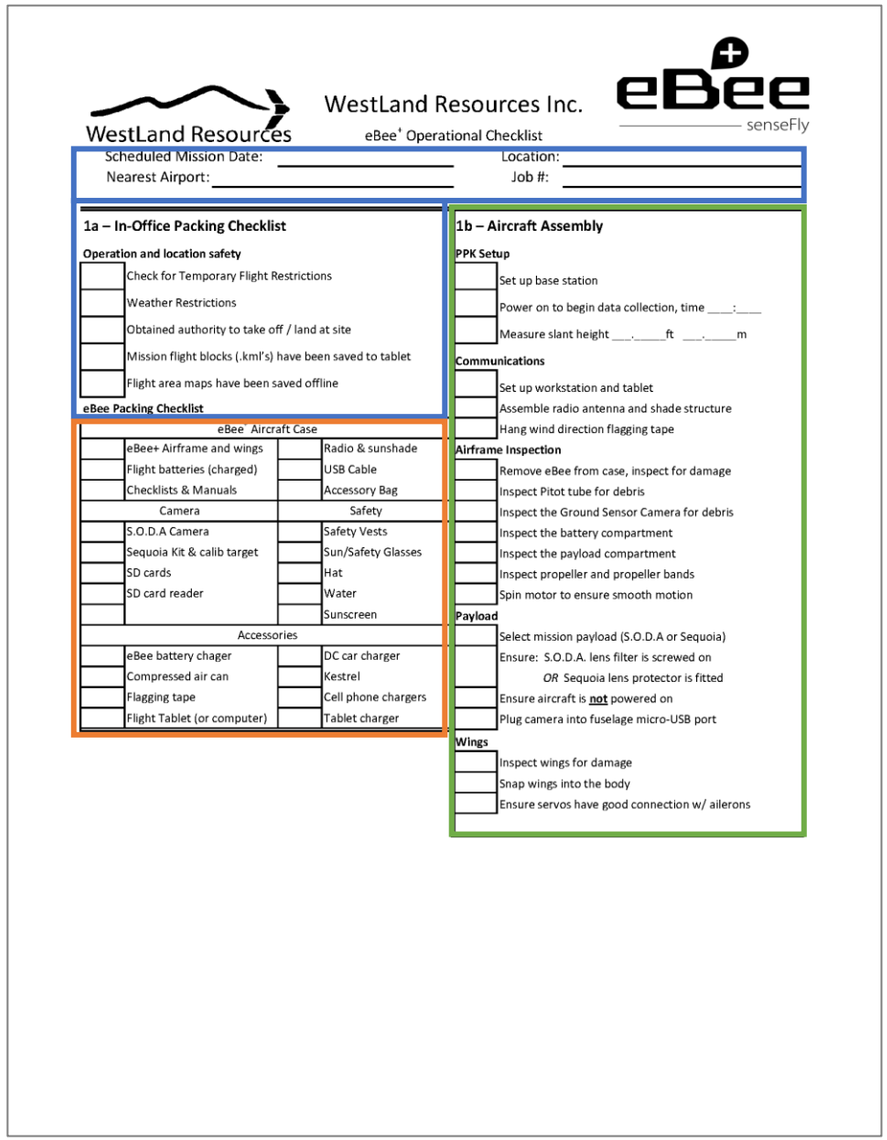
Mission / In-Office

An in-office checklist is crucial to the success of a mission, or at the very least, will help in-field operations move as smoothly as possible. This section should be utilized in the weeks/days leading up to and include the day of the flight to ensure the flight has been properly planned and the flight area is safe given current weather and airspace conditions. This section is commonly expanded to include checklists to aid in mission planning, such as flight area size, battery management, or takeoff and landing spot identification.

The in-office checklist can be systematically broken down into a timeline to aid in the pre-flight workflow. For instance, have an initial section for flight planning, airspace authorizations, etc. Then lead into a “1 week prior” section for NOTAM submission and further weather checks. Then “one day prior” for battery charging and SD card preparation. Finally, a “day of” checklist to ensure weather is still safe and there are no unexpected TFRs.

Use In-office checklists to ensure all satellite base maps, flight lines, and other mission critical items are saved to the flight controlling device. Even if the flight area does have cellular data service, it is best to be prepared for an “offline” scenario.

Finally, mission names, dates, locations, and job numbers should be finalized In-office. These simple tools are helpful in post-flight mission logging and data organization.



WestLand Resources

WestLand Resources Inc.

eBee senseFly

eBee' Operational Checklist

Scheduled Mission Date: _____ Location: _____

Nearest Airport: _____ Job #: _____

1a – In-Office Packing Checklist

Operation and location safety

- [ ] Check for Temporary Flight Restrictions
- [ ] Weather Restrictions
- [ ] Obtained authority to take off / land at site
- [ ] Mission flight blocks (.kml's) have been saved to tablet
- [ ] Flight area maps have been saved offline

eBee Packing Checklist

eBee Aircraft Case

- [ ] eBee+ Airframe and wings
- [ ] Flight batteries (charged)
- [ ] Checklists & Manuals
- [ ] Radio & sunshade
- [ ] USB Cable
- [ ] Accessory Bag

Camera

- [ ] S.O.D.A Camera
- [ ] Sequoia Kit & calib target
- [ ] SD cards
- [ ] SD card reader

Safety

- [ ] Safety Vests
- [ ] Sun/Safety Glasses
- [ ] Hat
- [ ] Water
- [ ] Sunscreen

Accessories

- [ ] eBee battery chager
- [ ] Compressed air can
- [ ] Flagging tape
- [ ] Flight Tablet (or computer)
- [ ] DC car charger
- [ ] Kestrel
- [ ] Cell phone chargers
- [ ] Tablet charger

1b – Aircraft Assembly

PPK Setup

- [ ] Set up base station
- [ ] Power on to begin data collection, time ____:____
- [ ] Measure slant height ___._____ft ___._____m

Communications

- [ ] Set up workstation and tablet
- [ ] Assemble radio antenna and shade structure
- [ ] Hang wind direction flagging tape

Airframe Inspection

- [ ] Remove eBee from case, inspect for damage
- [ ] Inspect Pitot tube for debris
- [ ] Inspect the Ground Sensor Camera for debris
- [ ] Inspect the battery compartment
- [ ] Inspect the payload compartment
- [ ] Inspect propeller and propeller bands
- [ ] Spin motor to ensure smooth motion

Payload

- [ ] Select mission payload (S.O.D.A or Sequoia)
- [ ] Ensure: S.O.D.A. lens filter is screwed on *OR* Sequoia lens protector is fitted
- [ ] Ensure aircraft is **not** powered on
- [ ] Plug camera into fuselage micro-USB port

Wings

- [ ] Inspect wings for damage
- [ ] Snap wings into the body
- [ ] Ensure servos have good connection w/ ailerons

Packing

Proper packing prevents perpetually poor performance. As such, having an exhaustive packing list is an invaluable asset. Few mistakes waste more time than forgetting a key operational item. Packing items such as the aircraft, controller, and batteries may sound too obvious to forget, but why take the risk? Even the absence of seemly “non-critical items” can cause delays or worse. Items such as sunscreen, pens, and a phone charger should be considered critical items, as their absence may create distractions for the PIC or create a safety hazard. No item is too small or too large to list here! It’s all too easy to forget something as small as a pen, but it’s a big pain to work without.

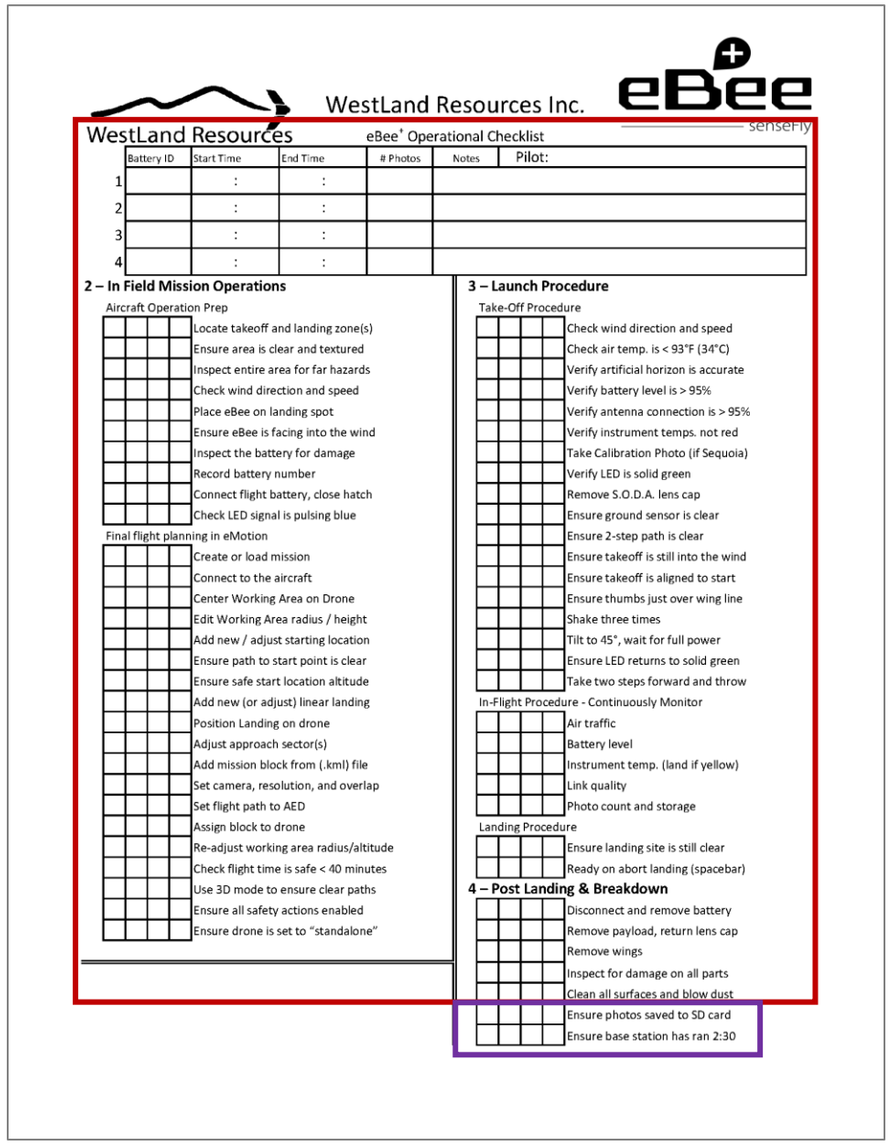
Often, this checklist will need to be updated to include additional items as more missions are flown and operational needs are refined. Longer, multi-day operations will require significantly more packing items. Consider the additional demands carefully to include items such as laptop and phone chargers. Finally, these packing lists should be airframe specific, as each aircraft will require its own set of equipment.

Pre-Flight

The pre-flight checklist is geared towards in-field use. Mainly this section will guide the PIC through the final stages of analyzing the operational area and preparing the aircraft for flight. Some items in this section may be general, applying to most operations, such as checking the flight area for hazards, while others should be specialized to the aircraft in use, such as finalizing the takeoff and landing areas. The items in this section should only have to be completed once per mission or per operating area. If the mission consists of multiple flights, generally this section would not need to be completed each flight, although the PIC should be aware of changing circumstances.

Operational

The operational checklist should give the PIC a step-by-step procedure to prepare the aircraft for and takeoff, guide the PIC through takeoff, and list any mid-flight actions. It should include hardware readiness checks, settings checks, flight path verification, and other flight specific items. The operational checklist must be aircraft specific and should be repeated with every flight. The detail and length of this section should reflect the complexity of the operation of the aircraft, i.e. a fixed wing should require significantly more operational items than a Phantom aircraft.



WestLand Resources Inc.

eBee SenseFly

WestLand Resources — eBee+ Operational Checklist

	Battery ID	Start Time	End Time	# Photos	Notes	Pilot:
1		:	:			
2		:	:			
3		:	:			
4		:	:			

2 – In Field Mission Operations

Aircraft Operation Prep

- Locate takeoff and landing zone(s)
- Ensure area is clear and textured
- Inspect entire area for far hazards
- Check wind direction and speed
- Place eBee on landing spot
- Ensure eBee is facing into the wind
- Inspect the battery for damage
- Record battery number
- Connect flight battery, close hatch
- Check LED signal is pulsing blue

Final flight planning in eMotion

- Create or load mission
- Connect to the aircraft
- Center Working Area on Drone
- Edit Working Area radius / height
- Add new / adjust starting location
- Ensure path to start point is clear
- Ensure safe start location altitude
- Add new (or adjust) linear landing
- Position Landing on drone
- Adjust approach sector(s)
- Add mission block from (.kml) file
- Set camera, resolution, and overlap
- Set flight path to AED
- Assign block to drone
- Re-adjust working area radius/altitude
- Check flight time is safe < 40 minutes
- Use 3D mode to ensure clear paths
- Ensure all safety actions enabled
- Ensure drone is set to “standalone”

3 – Launch Procedure

Take-Off Procedure

- Check wind direction and speed
- Check air temp. is < 93°F (34°C)
- Verify artificial horizon is accurate
- Verify battery level is > 95%
- Verify antenna connection is > 95%
- Verify instrument temps. not red
- Take Calibration Photo (if Sequoia)
- Verify LED is solid green
- Remove S.O.D.A. lens cap
- Ensure ground sensor is clear
- Ensure 2-step path is clear
- Ensure takeoff is still into the wind
- Ensure takeoff is aligned to start
- Ensure thumbs just over wing line
- Shake three times
- Tilt to 45°, wait for full power
- Ensure LED returns to solid green
- Take two steps forward and throw

In-Flight Procedure - Continuously Monitor

- Air traffic
- Battery level
- Instrument temp. (land if yellow)
- Link quality
- Photo count and storage

Landing Procedure

- Ensure landing site is still clear
- Ready on abort landing (spacebar)

4 – Post Landing & Breakdown

- Disconnect and remove battery
- Remove payload, return lens cap
- Remove wings
- Inspect for damage on all parts
- Clean all surfaces and blow dust
- Ensure photos saved to SD card
- Ensure base station has ran 2:30

Post-Flight

The post-flight checklist should be completed at the end or a mission, or when moving projects areas. It should include procedures to properly stow the aircraft and other flight equipment. Additionally, it may be useful to include checks to ensure the working area has been cleaned, such as picking up aerial targets, flagging tape, landing pads, etc. It is also highly recommended to add steps during this phase to verify that all data has been properly saved to the SD card and all flight logs have been recorded. These steps will also be aircraft and mission specific. For instance, Multi-Spectral flights may require radiometric calibration at the end of a mission, or flights using PPK may require additional checklist items to pack up a base station. Essentially, the post-flight checklist should ensure that you are prepared to return to the office with all equipment securely packed and all data in hand.

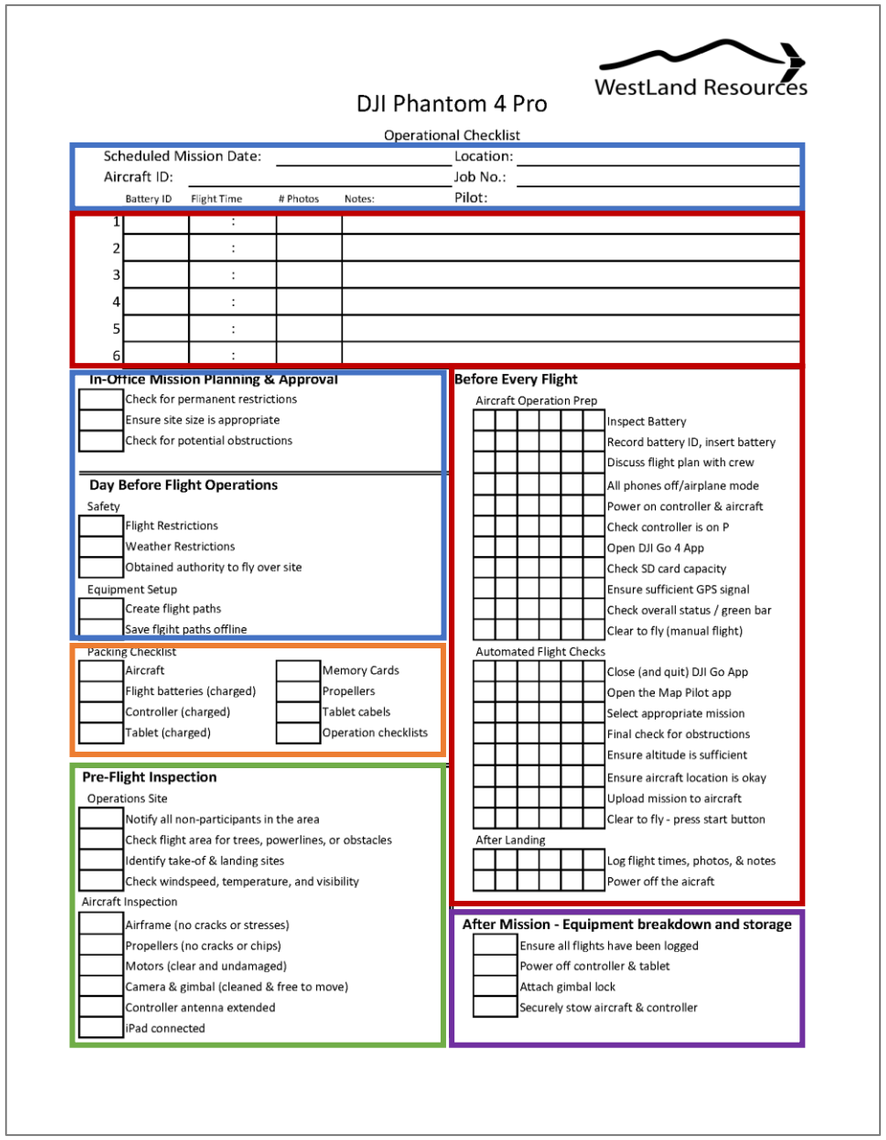
General Considerations

Checklists are only useful if they are used! With that being said, checklists are a balance between being quick but too sparse and perfectly thorough but impractically long. If the list is too short, critical details may be forgotten. On the other hand, if the checklist is too lengthy or detailed, the chances of the operator skipping or thoughtlessly checking boxes is increased. There is a happy medium where the checklist isn't unwieldy yet ensures all critical steps will be completed. The best, or at least safest, method (in our opinion) to optimizing the length vs detail of a checklist is to start at the longer end of the detail spectrum and methodically condense that checklist over time. Carefully consider your personal and external safety requirements and as you build and optimize your checklist to ensure they are not compromised by brevity.

On the other hand, if you find yourself repeatedly completing an action that isn't on your checklist, put that action somewhere in the checklist. It is probably a critical step if it is routinely done.

In general, is a good idea to have a "notes" section. This allows the operator to record any conditions surrounding the flight. This can be anything from weather and wind recordings, to flight anomalies, incidents, near misses, or potential suggestions for future checklist modifications.

Finally, have a system in place to archive your checklists. You can put "archive this checklist" right on the checklist!



WestLand Resources

DJI Phantom 4 Pro

Operational Checklist

Scheduled Mission Date: _____ Location: _____

Aircraft ID: _____ Job No.: _____

Pilot: _____

	Battery ID	Flight Time	# Photos	Notes:
1		:		
2		:		
3		:		
4		:		
5		:		
6		:		

In-Office Mission Planning & Approval

- ☐ Check for permanent restrictions
- ☐ Ensure site size is appropriate
- ☐ Check for potential obstructions

Day Before Flight Operations

Safety

- ☐ Flight Restrictions
- ☐ Weather Restrictions
- ☐ Obtained authority to fly over site

Equipment Setup

- ☐ Create flight paths
- ☐ Save flgiht paths offline

Packing Checklist

- ☐ Aircraft
- ☐ Flight batteries (charged)
- ☐ Controller (charged)
- ☐ Tablet (charged)
- ☐ Memory Cards
- ☐ Propellers
- ☐ Tablet cabels
- ☐ Operation checklists

Pre-Flight Inspection

Operations Site

- ☐ Notify all non-participants in the area
- ☐ Check flight area for trees, powerlines, or obstacles
- ☐ Identify take-of & landing sites
- ☐ Check windspeed, temperature, and visibility

Aircraft Inspection

- ☐ Airframe (no cracks or stresses)
- ☐ Propellers (no cracks or chips)
- ☐ Motors (clear and undamaged)
- ☐ Camera & gimbal (cleaned & free to move)
- ☐ Controller antenna extended
- ☐ iPad connected

Before Every Flight

Aircraft Operation Prep

- ☐ Inspect Battery
- ☐ Record battery ID, insert battery
- ☐ Discuss flight plan with crew
- ☐ All phones off/airplane mode
- ☐ Power on controller & aircraft
- ☐ Check controller is on P
- ☐ Open DJI Go 4 App
- ☐ Check SD card capacity
- ☐ Ensure sufficient GPS signal
- ☐ Check overall status / green bar
- ☐ Clear to fly (manual flight)

Automated Flight Checks

- ☐ Close (and quit) DJI Go App
- ☐ Open the Map Pilot app
- ☐ Select appropriate mission
- ☐ Final check for obstructions
- ☐ Ensure altitude is sufficient
- ☐ Ensure aircraft location is okay
- ☐ Upload mission to aircraft
- ☐ Clear to fly - press start button

After Landing

- ☐ Log flight times, photos, & notes
- ☐ Power off the aicraft

After Mission - Equipment breakdown and storage

- ☐ Ensure all flights have been logged
- ☐ Power off controller & tablet
- ☐ Attach gimbal lock
- ☐ Securely stow aircraft & controller